EFFICIENCY AND QUALITY

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USE OF MAGNETIC SEPARATION IN PRODUCTION OF ELECTROMELTED REFRACTORIES

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It is demonstrated that magnetic separation of crushed bacor (virgin and recycled bacor waste) on the magnetic separator produced by ÉMKO Electromechanical company made it possible to improve the quality of the finished products.

Removal of iron-containing impurities from materials and processed products is a prerequisite to the improvement of the quality and, accordingly, the competitiveness of glass and ceramic articles. Publications [1, 2] discuss the magnetic separation process and the equipment recommended for magnetic concentration (removal of magnetic impurities) of materials used in ceramic and glass industry. In contrast to industrialized capitalist countries, highly efficient magnetic separation has not yet gained wide acceptance in the practical production of glass and ceramics in Russia.

The present paper describes a positive experience of the operation of the magnetic separator UMO-2B-K made by the EMKO Electromechanical Company in the production of bacor refractories at the Shcherbinskii Works.

The technology of making electromelted baddeleite-corundum refractories (hereafter "bacor") consists of arc fusion of the material mixture comprising concentrated zirconium and silicon oxides, sodium oxide, zirconium dioxide, alumina (99.2% Al_2O_3, hereafter weight content is indicated), as well as virgin bacor waste in crumbs or recycled bacor waste received from glass factories, constituting 30 – 60% of the batch. Virgin and recycled bacor crumbs are obtained by crushing in a jaw crusher and a conic inertial crusher; then the crushed recycled waste is screened on a Grokhot-GISP-23 set. According to the factory lab data, the ferric oxide content in the bacor products of the Shcherbinskii works before magnetic separation was introduced amounted to 0.11 – 0.12%, whereas this parameter in the products of leading foreign producers is around 0.08%.

[1] Shcherbinskii Electromelted Refractories Works Joint-Stock Company, Moscow Region, Russia; ÉMKO Electromechanical Company, Moscow, Russia.

With the aim of improving the quality of bacor products, it was decided to introduce magnetic separation of batch materials, using the expertise of the ÉMKO Electromechanical Company.

The performed analysis indicated that the initial batch materials contain iron (converted to Fe_2O_3) in small quantities (%): up to 0.03 in alumina, up to 0.065 in the concentrate, up to 0.10 in zirconium dioxide; therefore, these materials do not require magnetic concentration. The chemical analysis of the bacor waste of the fraction below 10 mm established that the average content of ferric oxide is around 0.40 and 0.20% in the virgin waste produced by the factory and the recycled waste, respectively. Such high content of iron made it necessary to use magnetic concentration of the crushed bacor waste (both virgin and recycled).

In order to select the optimum magnetic concentration scheme and the optimum parameters for the magnetic system of the separator, qualitative analysis of iron-containing impurities in the crushed virgin and recycled bacor waste of the less than 10 mm fraction was carried out. It was found that the virgin crumb (the factory bacor waste) contains the following principal iron-bearing impurities: fragments of destroyed armored plates of the crusher (size below 10 mm, degree of saturation magnetization from about 0 to 0.2 T), fine steel grating oxidized to various degrees (size below 1 mm, degree of magnetization from 0.4 to 2.0 T), and refractory particles of size below 1 mm with a perceptible magnetic moment. The analysis of the recycled bacor waste indicated the presence of three types of iron-containing impurities: fine steel grating oxidized to various degrees (size below 1 mm, degree of magnetization from 0.4 to 2.0 T), refractory particles of size below 1 mm with a perceptible magnetic mo-

ment, and particles of slag lining on recycled bacor crumbs, which are formed in the course of glass-melting furnace operation. The magnetic parameters of the particles with the slag lining traces are mainly determined by the volume fraction of the slag lining and have a saturation magnetization of not more than 0.1 T.

The significant difference in the magnetic parameters of iron-bearing impurities made it necessary to use a two-stage magnetic separation scheme, in which strongly magnetic impurities are extracted at the first stage, and after that, the weakly magnetic fraction is extracted. The magnetic separator was designed for an output of up to 2000 kg/h for the bacor fraction less than 10 mm in size. The first stage separator has the following magnetic characteristics: magnetic intensity 0.3 T, magnetic field gradient 0.015 T/cm; and the second stage separator has 0.7 T and 0.15 T/cm, respectively. The first stage of separation was intended for the extraction of the highly magnetic fraction, i.e., steel grating, particles with slag lining fragments, and armored plate fragments with a sufficiently high magnetic moment. The second stage was for extraction of the weakly magnetic faction: armored plate fragments and particles with slag lining inclusions which have a low magnetic moment, as well as fine “magnetic” particles which are visually indistinguishable from the bacor particles.

The UMO-2B-K magnetic separator (a two-drum ceramic magnetic separation set) installed at the batch preparation site of the Shcherbinskii Works is shown in Fig. 1. The magnetic systems of the separator are based on the most powerful permanent magnet: the Nd – Fe – B magnet produced by the ÉMKO Electromechanical Company. Both separation phases are provided with self-purifying drum magnetic separators.

The separation of the “magnetic” and “nonmagnetic” materials in drum separators proceeds as they move over the nonmagnetic stainless steel shell rotating around the immobile magnetic system. The magnetic systems take from 120 to 180° of the drum circumference. Magnetic impurities are attracted toward the drum surface and retained by the magnetic attraction force in the zone of action of the magnetic system. The rotating shell removes the magnetic impurity from the zone of magnetic force action, and the drum is unloaded. As the magnetic attraction force has no effect on the main product, it almost instantly leaves the drum under the effect of the centrifugal and gravity forces. The magnetic impurities are attracted to the drum surface by the magnetic attraction force and carried by the rotating shell underneath the drum to the zone for magnetic impurity discharge.

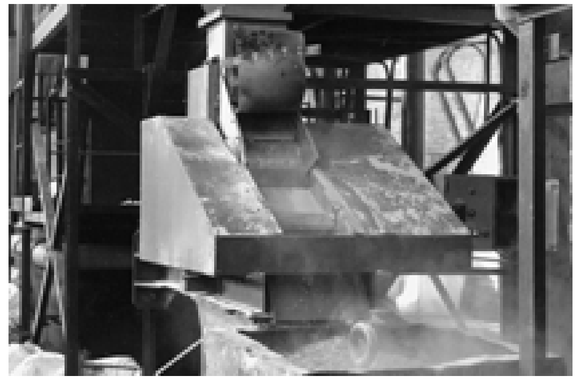

Fig. 1. Magnetic separator UMO-2B-K.

The four-month operational experience of the UMO-2B-K separator suggests the following conclusions.

When crushed virgin waste sized below 10 mm with an average iron oxide content of 0.40% passes through the magnetic separator, the resulting concentration fraction has a mean iron oxide content of 0.120 – 0.125%. The iron oxide content in the concentrated product is reduced to less than one-third.

In passing crushed recycled bacor waste sized 10 mm with an average iron oxide content of 0.20% through the magnetic separator, the resulting concentration fraction has a mean iron oxide content of 0.055 – 0.060%. The iron oxide content in the concentrated product is reduced about 3.5 times.

After the virgin and recycled bacor waste introduced to the batch in amounts of 30 and 60%, respectively, were subjected to magnetic separation, the ferric oxide content in the bacor products decreased from 0.11 – 0.12 to 0.08%, i.e., nearly 1.5 times lower.

The high efficiency and output of the separator fully satisfies the production needs of the Shcherbinskii Works.

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